The inefficacy of superficial similarities for improving instructor-student relationships[*]

Replicating 'Taking It to the Next Level'

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Abstract

This paper replicates the 2019 article 'Taking It to the Next Level' (Robinson, Scott, and Gottfried 2019), which evaluates an intervention to improve college instructor-student relationship. The modeling results indicate that the intervention, consisting of informing instructors and students about commonalities, has a weak positive effect on student perceptions of instructor-student similarity, but no effect on student perceptions of instructor-student relationship, instructor perception of similarity or instructor-student relationship, grades, or re-enrollment. While the scalability and affordability of the intervention are desirable, there are no results in any of the targeted measures: those that affect and reflect college retention. These results are consistent with the original paper. TODO: revise to clearliy indicate my own findings

Keywords: instructor-student relationship, college, replication study

Contents

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[*]Code and data are available at: github.com/amycfarrow/takingittothenextlevelrepro.

1 Introduction

TODO: one more paragraph for the introduction - quick summary of significance from lit review, also look at rubric.

Robinson, Scott, and Gottfried (2019)'s paper, "Taking It to the Next Level: A Field Experiment to Improve Instructor-Student Relationships in College", tests an intervention to improve college retention and performance. In this field experiment, they tested the effect of instructor-student similarity on instructor-student relationships (ISRs) and measures of student success. Based on extensive K-12 research about the importance of instructor-student relationship for student success, Robinson, Scott, and Gottfried (2019) aimed to establish how instructor-student relationships could be improved at the college level, and to test if this improvement had a positive result. The experiment consisted of a randomized controlled trial where some undergraduate students were informed of similarities they shared with their instructor, while others were not. Student and instructor perceptions of similarity and the instructor-student relationship were measured through surveys, and student performance measures were collected from school records.

This paper replicates Robinson, Scott, and Gottfried (2019)'s original analysis, using anonymized data provided by the authors. First, methods are discussed, and the measures and scales created by Robinson, Scott, and Gottfried (2019) are evaluated. Second, different demographics of instructor and student populations are explored, similarity of treatment and control groups is established, outcomes of interest are compared for treatment and control groups, and missing data is evaluated. Third, Robinson, Scott, and Gottfried (2019)'s models are replicated, and additional models are explored. Linear, logistic, and ordinal logistic models are replicated to predict outcomes including ISR perception, grade, and persistence. These models show that treatment slightly improves student perception of instructor-student similarity, but does not significantly affect student or instructor ISR perception, grades, or persistence. Replicating exploratory models, the relationship between similarity and relationship, as well as between relationship and student outcomes, are modeled. Additional models use different controls–specifically, variables indicating shared racial and gender self-identification. As with the replication models, treatment has no significant impact on ISR perception or student outcomes.

1.1 Literature review

College is perceived to be a meritocratic tool for social mobility and career success (Bowen, Chingos, and McPherson 2009). Unfortunately, retention is a large problem in contemporary American colleges, and many students begin degrees without completing them; six-year completion rates for full-time first-time students range from 51% to 86%, depending on school (Delbanco 2015). Even when controlling for pre-college test scores and initial enrollments, completion rate disparities exist based on parental education, socio-economic status, and race/ethnicity (Delbanco 2015). Disparities in college completion lead to further entrenchment of long-standing inequalities (Delbanco 2015). Thus, measures to help students persist in college completion are desirable to reduce wasted resources and to increase societal equity.

Many causes, and corresponding solutions, have been theorized for the 'college completion crisis'. In his examination of persistence research, Reason (2009) considers student precollege characteristics (sociodemographic traits, academic preparation and performance, and dispositions), organizational factors (structural-demographic characteristics and organizational behavior dimensions), student peer environment (campus

racial and academic climates), and individual student experiences (curricular, classroom, and out-of-class experiences). Such reviews indicate the sheer complexity involved. Implementing an effective intervention is difficult due to complicated causes of attrition, embedded social inequalities, and expenses (Tinto 2006).

Interventions targeting non-academic factors are popular. For example, using a randomized controlled trial, Evans et al. (2020) implemented a case management intervention, where social workers helped students with financial assistance, course selection, finding childcare, and accessing social services. The case management intervention significantly improved persistence rates (Evans et al. 2020). First year programs that are separate from academic faculty are popular, but increasingly there is a focus on the classroom's importance for retention (Tinto 2006). Tinto (1997) evaluated the impact of a college program designed for communal learning, which aims to engage students more than traditional programs. They found that students in the communal program participated in more academic activities, reported more positive views of the college and their role in it, and persisted at higher rates than the control (Tinto 1997).

Especially at the elementary and secondary level, many interventions to improve student outcomes do so by targeting ISRs. Roorda et al. (2011) performed a meta-analysis of 99 studies on teacher-student relationships and student engagement and achievement. Effect sizes were larger for engagement than for achievement, and the effect sizes varied widely based on the specific measurements being used (Roorda et al. 2011). They found stronger effects of teacher-student relationships in the upper secondary level, as compared to the lower elementary level (Roorda et al. 2011). At the college level, Tinto (2006) argues that the instructor is a key player in student retention. Creasey, Jarvis, and Gadke (2009) found that students who had connected, nonthreatening relationships with their instructors had more positive feelings about their own abilities and expectations for the course.

ISRs are built on a range of social behaviors and experiences, but similarity's effect on ISRs is of particular interest for this study. This is a specific case of a wider field of study: how does similarity affect all types of relationships? In general, people are more likely to persist in building relationships with acquaintances that they share similarities with, including prejudices, behaviors, personality traits, attitudes, demographics, and activities (Bahns et al. 2017). In mentoring relationships, perceived deep similarity contributes to information sharing behavior and positive reception, which then is positively associated with mentee adjustment (Zheng et al. 2021).

Other studies consider similarity and student performance, but do not directly address ISRs. One study of Taiwanese high school students explored the link between shared education and life values and student performance (Lai 2015). While they found a significant, but small, positive relationship between life values and student performance on analytic tests, education values gave mixed results depending on the natures of the education value and the analytic test in question (Lai 2015). At the college level, Abrami and Mizener (1985)'s study found a small correlation between students' perceiving instructors' attitudes to be similar to their own and the grades of those students, but the correlation became insignificant when instructor fixed effects were considered. In the college context, the link between similarity and grades is not well-established.

Beyond the wide range of research that addresses similarity, ISRs, and student outcomes, Robinson, Scott, and Gottfried (2019) was directly inspired by two previous works in middle and high schools. Gehlbach, Brinkworth, and Harris (2012)'s study of middle-school students found that students' perceived similarity to their teachers positively correlated with improvements in teacher-student relationship, and that changes in teacher-student relationships are associated with changes in student perceived self-efficacy, but not scholastic performance. Using a randomized controlled trial and surveys, Gehlbach et al. (2015) found that when high school students were presented with similarities they shared with their teachers, they subsequently perceived greater similarity with their teachers. When teachers were presented with similarities, they perceived better relationships with those students, and those students subsequently performed better academically. For students, however, awareness of similarities did not effectively improve their perception of the student-teacher relationship.

2 Methodology

Robinson, Scott, and Gottfried (2019) conducted a randomized controlled trial to assess the impact of awareness of instructor-student similarities on similarity perception, instructor-student relationship, course grade, and re-enrollment.

2.1 Participants

The study took place in the 2017 spring term at a large Californian University. The study included 120 instructors and their 2,749 students. The instructors participated in the study based on interest and a gift-card incentive, and their students were invited to participate unincentivized. Students were only enrolled in the study for one class, in the event that they were taking classes with multiple participating instructors. The initial sample of 147 instructors was a convenience sample: the study was advertised, interested instructors signed up and were enrolled if their course met the study requirements. 145 instructors consented and took the initial survey, resulting in an corresponding sample of 3,352 students. Once errors of administration, missing responses, and inadequate time spent on surveys were considered, the sample consisted of only 119 instructors and 2,273 students.

2.2 Treatment and control

Participating students were randomly assigned to either treatment or control. At the beginning of the term, all participating students and instructors were given "get to know you" surveys. Using those responses, for each student in the treatment group, seven commonalities were identified between student and instructor (for example, perhaps both student and instructor binge-watch TV to relieve stress, or appreciate loyalty as the most important friend quality), and both student and instructor were informed of these commonalities. They completed a few questions about the similarities and were reminded of them through the term to ensure they were internalized. Students in the control group were informed about similarities they shared with students in another part of the country, and instructors were told nothing about these students.

2.3 Procedures

All students participated in a survey immediately following the treatment or the placebo. They were surveyed again at the end of the course. Instructors were surveyed only at the end of the course.

2.4 Measures

Robinson, Scott, and Gottfried (2019) identify key measures. Full descriptions of all measures are available in Appendix A.

Some are extracted from the student survey at the beginning of the term:

1. Immediately after the treatment or placebo, students answered six questions about their perceived similarity to the instructor, on scales of 1 to 5. These responses were averaged to create a student perceived similarity scale.
2. Immediately after the treatment or placebo, students answered seven questions about their anticipated instructor-student relationship, on scales of 1 to 5. These responses were averaged to create a student anticipated ISR scale.

Others are extracted from the student survey at the end of the term:

3. At the end of the term, students answered the student perceived similarity scale questions again.
4. At the end of the term, students answered seven questions about their perception of the instructor-student relationship, on scales of 1 to 5. These responses were averaged to create a student perceived ISR scale.

Others come from the instructor survey at the end of the term:

5. Instructor similarity perception: At the end of the term, instructors answered only one question about similarity with the student, on a scale of 1 to 5.
6. Instructor perceived ISR scale: At the end of the term, instructors answered seven questions about their perception of the instructor-student relationship, on scales of 1 to 5. These responses were averaged to create an ISR scale.
7. Final grade: Instructors were asked to report the student's grade on their final exam, paper, or project.

Finally, some are extracted from the university's internal records:

8. The grade that the student received in the course.
9. The student's course grade, standardized against other grades in the course.
10. Persistence: The student's status as of Fall term 2017: not enrolled or enrolled.

2.4.1 Scale Reliability

A scale is externally reliable if it gives the same results across different testings (Coolican 2014). Test-retest reliability, where a scale is given to a group at different times, is a common way to assess this (Coolican 2014). In our data, there is a retest, but interactions between instructors and students may reasonably be expected to affect the second testing, rendering the data unuseful for assessing test-retest reliability.

A scale is internally reliable if it is consistent within itself (Coolican 2014). Cronbach's alpha was used to assess the reliability of the similarity and ISR scales. This statistic evaluates how much participants vary on individual items, compared to how they vary overall (Coolican 2014). Good reliability is indicated by an alpha between .75 and 1 (Coolican 2014). For the initial student perceived similarity scale, student anticipated ISR scale, end-of-term student perceived similarity scale, end-of-term student perceived ISR scale, and end-of-term instructor perceived ISR scale, $\alpha = 0.892, 0.872, 0.91, 0.905$, and 0.926, respectively, indicating that the scales are reliable.

2.4.2 Scale Validity

A scale is valid if it measures what it is supposed to measure (Coolican 2014). In this case, the scales should measure similarity perception and instructor-student relationship (ISR) perception. Robinson, Scott, and Gottfried (2019) used modified versions of the scales from Gehlbach et al. (2015), where they were used with ninth-grade American students and their teachers; the scales were originally were presented in Gehlbach, Brinkworth, and Harris (2012), and they were developed for use with sixth-, seventh-, and eight-grade American students and their teachers. Given the fact that these scales were developed for children, it is worth considering what the scales actually measure. To do this, we can look at the specific questions in the three distinct scales.

To assess similarity, students were asked about values, course goals, views on course content, general commonalities, personality, and overall similarity. By this standard, high similarity is when a student shares values, course goals, and views on course content, and the student and instructor have similar personalities, high commonality, and high general similarity. Questions ask about course-specific measures (content and goals), personal traits (values and personality), and non-specific traits (commonalities and general similarity), but do not ask about life experience, abilities, or approaches, amoungst other ways that two people can theoretically be similar.

To assess ISR, students were asked about enjoyment of learning, friendliness, encouragement, excitement, motivation, caring, and overall learning. By this standard, a high-quality ISR is one where a student enjoys learning from, is motivated by, and learns a great deal from a friendly, encouraging, caring instructor, who would be excited to see them in three years time. To assess ISR, instructors were asked about enjoyment of aiding learning, caring, frequency of encouragement, friendliness, excitement, motivation, and overall learning. By this standard, a high-quality ISR is one where an instructor enjoys helping and frequently encourages a friendly, caring student who is motivated and learns a great deal from this instructor, and the instructor would be excited to see the student in three years.

As Brinkworth et al. (2018) argue, the instructor-student relationship is conceptualized, and therefore measured, in a variety of ways. Other constructions of ISR scales may measure negative aspects, respect,

Table 1: Student covariates for treatment and control groups

Group	N	Missing		Control	Treatment	Total	p
				N(%) = 1137 (50.0)	N(%) = 1136 (50.0)	N(%) = 2273	
Student gender	2273	0	Male	432 (38.0)	416 (36.6)	848 (37.3)	0.526
			Female	705 (62.0)	720 (63.4)	1425 (62.7)	
Student race	2273	0	American Indian	1 (0.1)		1 (0.0)	0.639
			Asian	126 (11.1)	124 (10.9)	250 (11.0)	
			Black	51 (4.5)	43 (3.8)	94 (4.1)	
			Hispanic	513 (45.1)	556 (48.9)	1069 (47.0)	
			Middle Eastern	54 (4.7)	55 (4.8)	109 (4.8)	
			Mixed race	113 (9.9)	111 (9.8)	224 (9.9)	
			Other	40 (3.5)	31 (2.7)	71 (3.1)	
			Unknown	2 (0.2)	3 (0.3)	5 (0.2)	
			White	237 (20.8)	213 (18.8)	450 (19.8)	
Student first-gen status	2270	3	No	634 (55.8)	648 (57.1)	1282 (56.5)	0.550
			Yes	502 (44.2)	486 (42.9)	988 (43.5)	
Year	2246	27	1	78 (6.9)	74 (6.6)	152 (6.8)	0.977
			2	178 (15.8)	180 (16.1)	358 (15.9)	
			3	191 (17.0)	182 (16.2)	373 (16.6)	
			4	665 (59.1)	668 (59.6)	1333 (59.3)	
			5	14 (1.2)	16 (1.4)	30 (1.3)	
Student age	2269	4	Mean (SD)	22.6 (5.4)	22.7 (5.3)	22.7 (5.4)	0.726
CPGA	2178	95	Mean (SD)	3.0 (0.6)	3.0 (0.7)	3.0 (0.6)	0.414

liking, responsiveness, engagement, trust, honesty, humour, interest, approachability, clarity, confidence, fairness, patience, and consistency (Brinkworth et al. 2018). Robinson, Scott, and Gottfried (2019)'s ISR scale is measuring only one concept of an ISR, and that particular concept needs to be considered when analyzing the results of this experiment. Like most research about ISRs, Robinson, Scott, and Gottfried (2019)'s scale originates in elementary and secondary schools, and the concept of "good ISR" may not translate easily to a post-secondary context.

3   Data

TODO: add all citations for R packages, R, and R markdown The correlation matrix was made using functions by Engineering (2018).

The data, in a .dta format, and Stata code for the Robinson, Scott, and Gottfried (2019) paper are available on the Inter-University Consortium for Political and Social Research (Carly D. Robinson, Scott, and Gottfried 2020). The dataset contains 36838 observations of 653 variables.

3.1   Demographics

Table 1 shows the student covariates for the treatment and control samples. There are no significant differences between the treatment and control groups.

Table 2 shows the instructor covariates. Because instructors are counted multiple times, for each student in the treatment and control groups that is in their course, only the totals are shown. The same covariates, presented by treatment and control groups, are shown in Appendix B.

There are differences between the students and instructors. Notably, the student sample is 62.7% female, while the instructor sample is 78.2% female. The student sample is 19.8% White, while the instructor sample is 38.7% White. The student sample is 47% Hispanic, while the instructor sample is only 3.4%. Finally, the student sample is 9.8% multiracial, but the instructor sample is 52.1% multiracial. Some of these differences

Table 2: Teacher covariates

	N	Missing		N = 119
Instructor gender	119	0	Male	26 (21.8)
			Female	93 (78.2)
Instructor race	119	0	Asian	4 (3.4)
			Black	2 (1.7)
			Hispanic	4 (3.4)
			Mixed race	62 (52.1)
			White	46 (38.7)
			Unknown	1 (0.8)
Instructor first-gen status	119	0	No	89 (74.8)
			Yes	30 (25.2)
Instructor age	118	1	Mean (SD)	44.5 (11.0)
Course size	118	1	Mean (SD)	36.4 (27.9)

may be due to self-identification: while one person who is Hispanic may select only Hispanic, another may select, for example, Hispanic as well as White, and be classed differently as a result. For this reason, it is very difficult to draw conclusions. Additionally, students are 43.5% first-generation college students, while only 25.2% of instructors are.

In light of the different percentages in student and instructor racial self-identification, Figure 1 shows the percentages of each group that selected a given racial identity, as well as the percentage that selected more than one of these categories. More students identified as Hispanic, while more instructors identified as White and multi-racial.
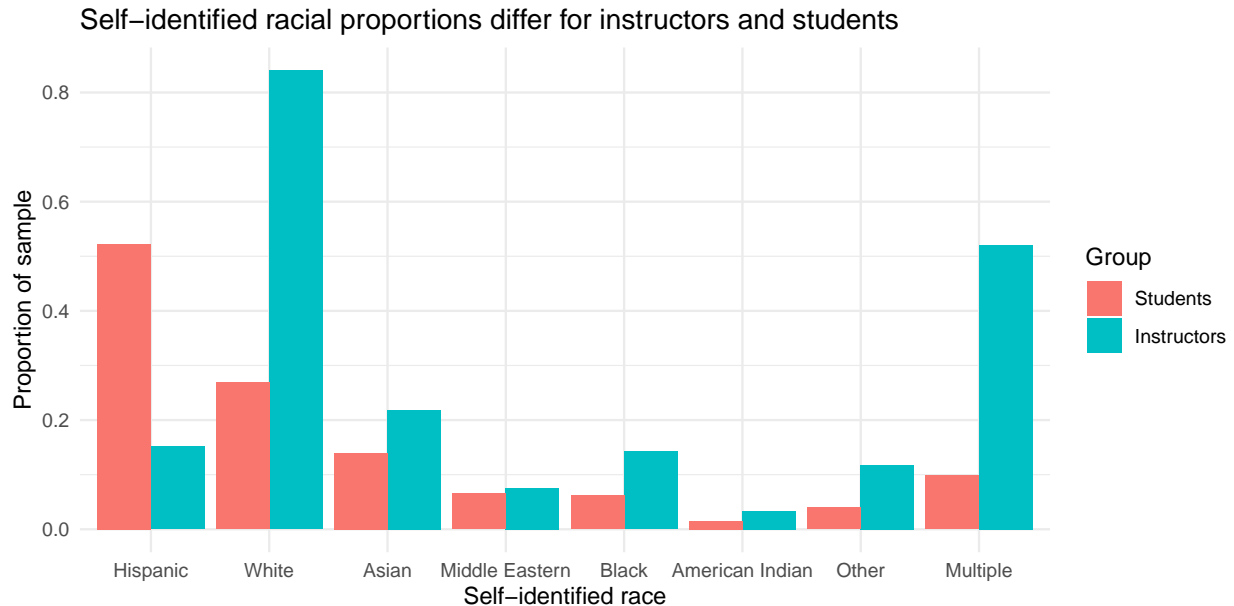

Figure 1: Bar chart illustrating racial identification proprtions of participants

Given the potential significance of class size for instructor-student relationships, Figure 2 shows the distribution of class sizes of instructors that participated in the study. Most class sizes are between 25 and 50

Table 3: Outcomes of interest for treatment and control groups

	N	Missing		Control	Treatment	Total	p
				N(%) = 1137 (50.0)	N(%) = 1136 (50.0)	N(%) = 2273	
Initial student perception							
Similarity	2272	1	Mean (SD)	3.4 (0.7)	3.6 (0.7)	3.5 (0.7)	<0.001
ISR	2273	0	Mean (SD)	4.1 (0.6)	4.1 (0.6)	4.1 (0.6)	0.997
End-of-term student perception							
Similarity	1831	442	Mean (SD)	3.5 (0.8)	3.6 (0.8)	3.6 (0.8)	0.004
ISR	1831	442	Mean (SD)	4.1 (0.7)	4.1 (0.7)	4.1 (0.7)	0.888
End-of-term instructor perception							
Similarity	2225	48	1	133 (11.9)	132 (11.9)	265 (11.9)	1.000
			2	344 (30.8)	343 (31.0)	687 (30.9)	
			3	402 (36.0)	400 (36.1)	802 (36.0)	
			4	171 (15.3)	166 (15.0)	337 (15.1)	
			5	67 (6.0)	67 (6.0)	134 (6.0)	
ISR	2240	33	Mean (SD)	3.5 (0.9)	3.5 (0.9)	3.5 (0.9)	0.639
Student outcomes							
Course grade	2147	126	Mean (SD)	3.1 (1.0)	3.1 (1.0)	3.1 (1.0)	0.702
Stand. grade	2120	153	Mean (SD)	0.1 (0.9)	0.1 (0.9)	0.1 (0.9)	0.517
Final grade	2109	164	Mean (SD)	3.0 (1.1)	3.0 (1.1)	3.0 (1.1)	0.525
Peristence	1786	487	No	59 (6.7)	68 (7.5)	127 (7.1)	0.553
			Yes	823 (93.3)	836 (92.5)	1659 (92.9)	

students, but there are some that are much larger.
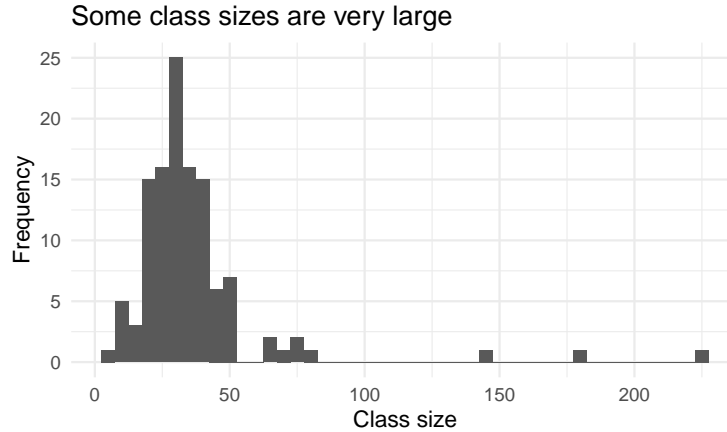
Figure 2: Histogram illustrating class sizes

3.2 Outcomes of interest

Table 3 shows summary statistics for key variables identified by Robinson, Scott, and Gottfried (2019), including missing values. There do not appear to be significant differences between the treatment and control groups, other than in student similarity perception. Even in these two measures, the difference appears to be small (mean scores of 3.4 versus 3.6 and 3.5 versus 3.6).

Figure 3 shows key continuous outcome distributions for both treatment and control. Corresponding to Table 3, the only visible differences in distributions are in the initial student similarity perception and end-of-term student similarity perception.

Most key outcomes unaffected by treatment

Figure 3: Histograms illustrating continous and ordinal key outcomes

Table 4: Correlation matrix for continuous and ordinal key variables and outcomes

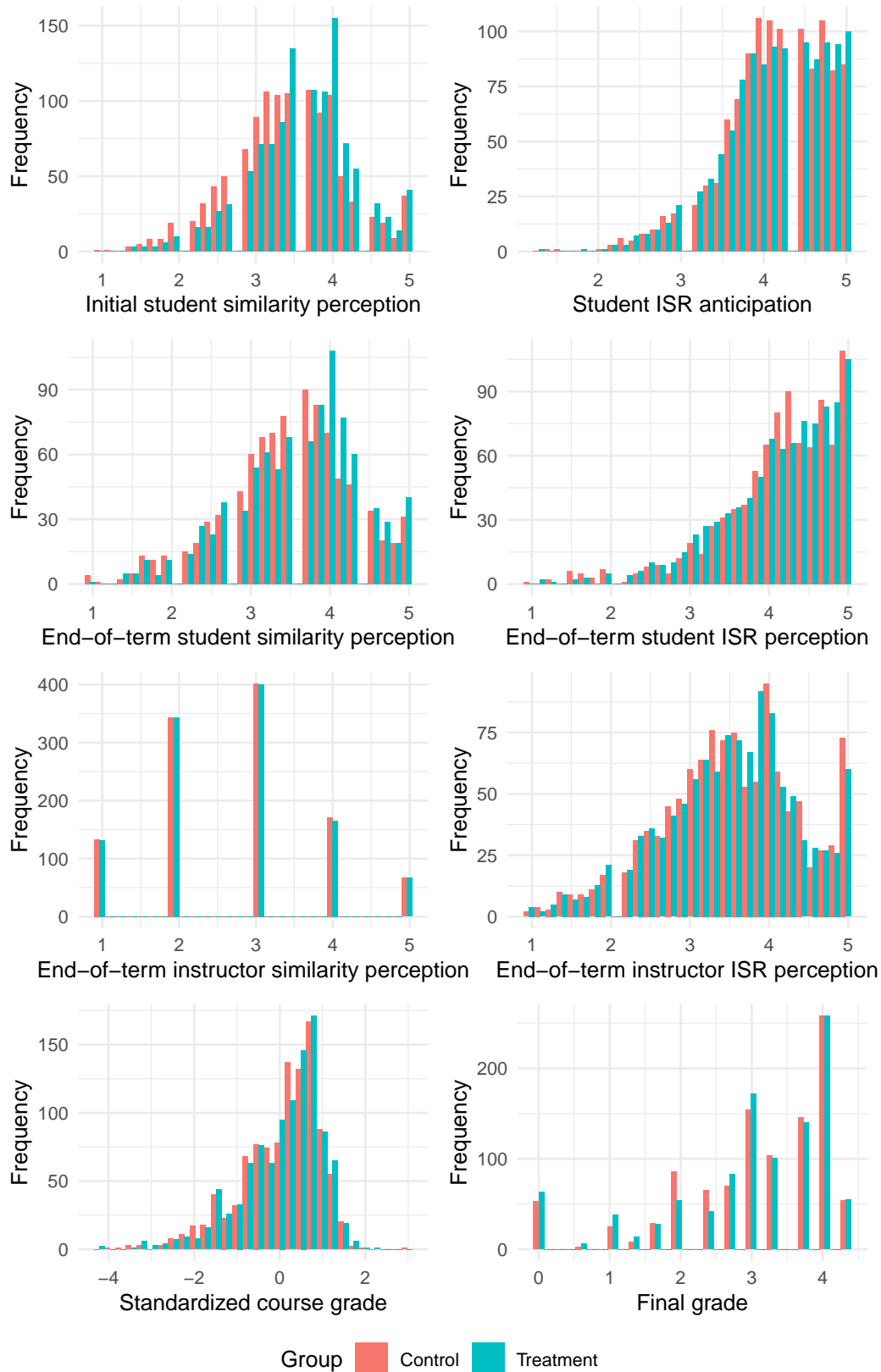| | N | Missing | Mean (SD) | Initial student | | End-of-term student | | End-of-term instructor | | Grades | |
				Similarity	ISR	Similarity	ISR	Similarity	ISR	Course	Stand. course
Initial student perception											
Similarity	2272	1	3.5 (0.7)	-							
ISR	2273	0	4.1 (0.6)	0.67***	-						
End-of-term student perception											
Similarity	1831	442	3.6 (0.8)	0.58***	0.5***	-					
ISR	1831	442	4.1 (0.7)	0.43***	0.57***	0.79***	-				
End-of-term instructor perception											
Similarity	2225	48	2.7 (1.0)	0.15***	0.16***	0.25***	0.24***	-			
ISR	2240	33	3.5 (0.9)	0.19***	0.21***	0.29***	0.33***	0.68***	-		
Grades											
Course	2147	126	3.1 (1.0)	0.07**	0.1***	0.2***	0.23***	0.38***	0.44***	-	
Stand. course	2120	153	0.1 (0.9)	0.02	0.01	0.12***	0.11***	0.29***	0.35***	0.81***	-
Final	2109	164	3.0 (1.1)	0.06**	0.1***	0.17***	0.18***	0.38***	0.43***	0.81***	0.62***
Obj. Final	538	1735	2.8 (1.2)	0.05	0.07	0.17***	0.15**	0.43***	0.52***	0.83***	0.64***

Replicating Robinson, Scott, and Gottfried (2019)'s study, Table 4 displays a correlation matrix for the measures that Robinson, Scott, and Gottfried (2019) identified as key. The very strong correlations (course grade and the standardized version, course grade and final grade, and course grade and objectively graded final grade) and some of the strong correlations (standardized course grade with final grade and objectively grade final grade) are entirely expected.

Other strong correlations are more interesting: initial student similarity and instructor-student relationship perceptions, end-of-term student similarity and instructor-student relationship perceptions, and end-of-term instructor similarity and instructor-student relationship perceptions. At a given moment in time, a participant's assessment of similarity and ISR are highly related. This could indicate that the two perception scales may not be measuring psychologically distinct concepts, or that feelings of similarity and good relationships are strongly associated in the classroom.

Moderate correlations exist between initial and end-of-term student similarity perceptions as well as initial and end-of-term student ISR perceptions, indicating that student perceptions change somewhat but not entirely through the term. There are some moderate correlations between instructor perceptions of similarity or ISR and course grade, final grade, and objectively graded final grade, perhaps indicating that instructor opinions of students are linked to student performance in some way.

3.3 Missing data

There are no significant patterns in missing data. Appendix C shows the distributions of key variables relative to missing data in other key variables.

3.4 Attrition

129 eligible instructors completed the first survey, but 6 of those instructors did not complete the second survey. Corresponding to the remaining 123 instructors, 2,801 students completed the first survey (1,392 in the treatment group, 1,409 in the control group), but 682 of those students did not complete the second survey (328 in the treatment group, 354 in the control group). The attrition in the treatment and control groups was comparable (24% in the treatment group, 25% in the control group).

3.5 Data selection

From the 36,838 observations, or potential units of study (corresponding to all undergraduate student records of the university), only 2,273 were used in analysis. Units of study were excluded because the instructor did not participate in the study (33,486); the student did not consent (123); the student did not spend more than a second reading the consent page (1); the initial student survey, initial instructor survey, or end-of-term

instructor survey was not complete (428); the instructor mistakenly administered the wrong survey (30); the course was online (20); the course was for graduate students (50); or a participant did not spend more than ten seconds reading and answering a page with five or more questions (427). The ten-second time limit is somewhat arbitrary, and a different choice could lead to different study results.

4 Models

4.1 Replication models

$treatment_i$ is the indicator that treatment was given.

X_{1i} is a vector of student-level covariates (student ISR anticipation, gender, CGPA). ISR anticipation is used as a control for end-of-term student ISR perception, while gender and CGPA are used as controls for grade based outcomes. Robinson, Scott, and Gottfried (2019) state this is because females earn higher grades generally.

X_{2j} is a vector of instructor-level covariates (course size, teacher ID).

ϵ_{ij} is a clustered residual.

β_0, $beta_1$, Γ_1, Γ_2, and a_k are coefficients on the resulting models.

4.1.1 Linear models

Equation (1) is Robinson, Scott, and Gottfried (2019)'s linear model, used for continuous outcomes. This include complete scale outcomes: initial student similarity perception (s1_sim), end-of-term student similarity perception (s2_sim), end-of-term student ISR perception (s2_tsr), and end-of-term instructor ISR perception (t2_tsr). Because these scales are created using 6-7 questions answered on a scale of 1 to 5, they have a total of 25 or 30 possible values, they can be treated as continuous variables and modeled using linear functions. It also includes grade-based outcomes: course grade (grade) and objectively graded exam grade (t2_finalexam), both of which are shown on a 4.0 GPA scale.

$$Outcome_{ij} = \beta_0 + \beta_1 treatment_i + X_{1i}\Gamma_1 + X_{2j}\Gamma_2 + \epsilon_{ij} \tag{1}$$

4.1.2 Ordinal logistic models

Equation (2) is Robinson, Scott, and Gottfried (2019)'s ordinal logistic model, used for the ordinal outcome, which is end-of-term instructor similarity perception (t2_sim1).

$$prob(outcome_{ij}) = a_k + \beta_1 treatment_i + X_{1i}\Gamma_1 + X_{2j}\Gamma_2 + \epsilon_{ij} > k \tag{2}$$

4.1.3 Logistic models

Equation (3) is Robinson, Scott, and Gottfried (2019)'s logistic model, used for the binary outcome, which is enrollment in Fall term 2017 (f17_enrolled).

$$prob(outcome_{ij}) = a_k + \beta_1 treatment_i + X_{1i}\Gamma_1 + X_{2j}\Gamma_2 + \epsilon_{ij} > k \tag{3}$$

4.2 Additional models

When creating additional models, I focused on three key outcomes: end-of-term student perceived similarity scale, end-of-term student perceived ISR scale, and standardized course grade. I selected these because interventions like Robinson, Scott, and Gottfried (2019)'s are aimed at improving student outcomes (like course performance) and perceptions that could improve student outcomes (like student ISR perception), and this particular intervention tries to accomplish these goals by improving similarity perception. Equation

(4) shows the linear model used. X_{3jk} represents student-instructor commonality covariates (matching racial self-ID, matching gender self-ID, age difference).

$$Outcome_{ij} = \beta_0 + \beta_1 treatment_i + X_{1i}\Gamma_1 + X_{2j}\Gamma_2 + X_{3jk}\Gamma_3 + \epsilon_{ij} \tag{4}$$

5 Results

5.1 Replication results

In Table 5, Model 1 shows a statistically significant relationship between treatment and initial student similarity perception ($\beta = 0.19$, 95% CI[0.135,0.246]). Model 2 shows a statistically significant relationship between treatment and student end-of-term similarity perception ($\beta = 0.118$, 95% CI[0.051,0.184]). However, both coefficients are minimal on a scale of 1 to 5.

Model 3 shows no significant relationship between treatment and student end-of-term ISR perception. However, it does show a significant correlation between student ISR anticipation and student end-of-term ISR perception ($\beta = 0.565$, 95% CI[0.519,0.611]). For every 1 point increase in ISR anticipation on a 1 to 5 scale, the expected increase in end-of-term ISR perception is 0.565.

Models 4, 5, 6, 7, and 8 show no significant relationship between treatment and instructor end-of-term ISR perception, course grade, objectively graded exam grade, instructor perception of similarity at the end of the term, and enrollment in the subsequent term.

Table 6 shows the same models as in Table 5, created only using the subset of Hispanic and/or Black college student participants. While the effect of treatment on student similarity perception is larger than for the general student population ($\beta = 0.21$, 95% CI[0.137,0.282] for initial perception; $\beta = 0.148$, 95% CI[0.06,0.237] for end-of-term perception), there is still no effect on ISR perception, instructor perception, or student outcomes.

Table 7 shows the same models as in Table 5, created only using the subset of first-generation college student participants. While the effect of treatment on student similarity perception is larger than for the general student population and the Black and/or Hispanic student participants ($\beta = 0.272$, 95% CI[0.188,0.357] for initial perception; $\beta = 0.165$, 95% CI[0.062,0.268] for end-of-term perception), there is still no effect on ISR perception, instructor perception, or student outcomes.

5.1.1 Exploratory replication results

Table 8 disregards the treatment condition, instead considering the relationship between student identity and similarity/ISR. While we cannot make causal inferences, we can explore relationships between the variables in this particular study. If a student identifies as first generation, or as Hispanic and/or Black, can we anticipate a different student or instructor ISR perception? There is a significant negative relationship between student identification as Hispanic and/or Black and end-of-term instructor ISR perception ($\beta = $ -0.1, 95% CI[-0.158,-0.041]).

Table 9 considers the relationship between similarity perception and ISR perception and the relationship between ISR perception and student outcomes. Again, because only the treatment was randomized, we cannot make causal inferences.

In Models 1 and 2, we can see that student and instructor similarity perception are both significantly related to student and instructor ISR perception.

Unsurprisingly, student similarity perception relates more strongly to student ISR perception ($\beta = 0.66$, 95% CI[0.631,0.688]), and instructor similiarity perception relates more strongly to instructor ISR perception ($\beta = 0.502$, 95% CI[0.472,0.533]). Additionally, course size is negatively related to student ISR perception ($\beta = $ -0.102, 95% CI[-0.178,-0.026]).

Models 3 and 4 show that student ISR perception and instructor ISR perception are both significantly related to course grade and final grade. Instructor perception is a stronger predictor ($\beta = 0.395$, 95% CI[0.343,0.447]

Table 5: Replication model results

	Dependent variable:							
	Student sim. 1	Student sim. 2	Student ISR 2	Instructor ISR 2	Course grade	Final grade	Instructor sim. 2	Persistence
	OLS	OLS	OLS	OLS	OLS	OLS	ordered logistic	logistic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.190***	0.118***	0.006	−0.019	0.043	0.005	−0.017	0.127
	(0.135,0.246)	(0.051,0.184)	(−0.044,0.057)	(−0.077,0.039)	(−0.026,0.113)	(−0.160,0.169)	(−0.176,0.142)	(−0.328,0.582)
Student ISR 1			0.565***					
			(0.519,0.611)					
Student female					−0.046	−0.146		−0.141
					(−0.126,0.034)	(−0.332,0.040)		(−0.682,0.400)
CGPA					0.651***	0.603***		1.018***
					(0.593,0.708)	(0.482,0.724)		(0.700,1.335)
Course size	0.145**	0.158**	−0.131**	−0.039	0.055	0.010***	0.205***	−6.099
	(0.026,0.264)	(0.026,0.289)	(−0.232,−0.030)	(−0.162,0.085)	(−0.089,0.199)	(0.004,0.015)	(0.201,0.210)	(−2,245.510,2,233.312)
Constant	−0.941	−1.694	4.771***	4.313**	−0.407	−0.483		182.465
	(−4.348,2.467)	(−5.458,2.070)	(1.891,7.650)	(0.782,7.844)	(−4.519,3.705)	(−1.260,0.294)		(−66,999.880,67,364.810)
Teacher fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,268	1,829	1,829	2,236	2,063	514	2,221	1,687
R^2	0.141	0.237	0.495	0.391	0.400	0.415		
Adjusted R^2	0.094	0.185	0.460	0.357	0.364	0.391		
Log Likelihood								−277.677
Akaike Inf. Crit.								793.353

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6: Replication model results: Hispanic and Black students only

	Dependent variable:							
	Student sim. 1	Student sim. 2	Student ISR 2	Instructor ISR 2	Course grade	Final grade	Instructor sim. 2	Persistence
	OLS	OLS	OLS	OLS	OLS	OLS	ordered logistic	logistic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.210***	0.148***	0.022	−0.044	0.031	−0.057	−0.012	−0.140
	(0.137,0.282)	(0.060,0.237)	(−0.045,0.088)	(−0.118,0.031)	(−0.062,0.124)	(−0.283,0.170)	(−0.230,0.206)	(−0.825,0.545)
Student ISR 1			0.542***					
			(0.481,0.604)					
Student female					−0.045	−0.047		−0.055
					(−0.155,0.065)	(−0.318,0.224)		(−0.859,0.748)
CGPA					0.702***	0.571***		1.474***
					(0.623,0.782)	(0.408,0.734)		(0.952,1.995)
Course size	0.153**	0.220***	−0.083	−0.100	−0.057	0.011***	0.059***	−6.266
	(0.011,0.296)	(0.056,0.385)	(−0.207,0.041)	(−0.246,0.047)	(−0.237,0.122)	(0.003,0.018)	(0.053,0.065)	(−2,261.108,2,248.577)
Constant	−1.144	−3.366	3.589**	5.985***	2.517	−0.672		185.866
	(−5.148,2.861)	(−7.986,1.255)	(0.134,7.045)	(1.872,10.098)	(−2.518,7.551)	(−1.761,0.417)		(−67,459.400,67,831.140)
Teacher fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,312	1,056	1,056	1,292	1,202	298	1,278	1,017
R^2	0.182	0.273	0.529	0.435	0.456	0.444		
Adjusted R^2	0.102	0.184	0.471	0.378	0.399	0.403		
Log Likelihood								-129.667
Akaike Inf. Crit.								487.334

Note:	*p<0.1; **p<0.05; ***p<0.01

Table 7: Replication model results: first-generation students only

	Student sim. 1	Student sim. 2	Student ISR 2	Instructor ISR 2	Course grade	Final grade	Instructor sim. 2	Persistence
	Dependent variable:							
	OLS	OLS	OLS	OLS	OLS	OLS	*ordered logistic*	*logistic*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.272***	0.165***	0.016	−0.034	0.006	−0.070	0.075	0.031
	(0.188,0.357)	(0.062,0.268)	(−0.063,0.096)	(−0.122,0.054)	(−0.104,0.115)	(−0.330,0.190)	(−0.182,0.333)	(−0.879,0.942)
Student ISR 1			0.533***					
			(0.459,0.606)					
Student female					−0.060	−0.062		−1.512**
					(−0.193,0.073)	(−0.383,0.258)		(−2.862,−0.163)
CGPA					0.672***	0.525***		2.114***
					(0.584,0.761)	(0.348,0.702)		(1.306,2.921)
Course size	0.083	0.243**	−0.100	−0.116	−0.016	0.013***	−0.098***	−6.871
	(−0.091,0.257)	(0.036,0.450)	(−0.261,0.061)	(−0.295,0.064)	(−0.240,0.208)	(0.004,0.021)	(−0.105,−0.090)	(−4,260.477,4,246.735)
Constant	0.733	−4.102	4.005*	6.322**	1.373	−0.629		202.761
	(−4.139,5.605)	(−9.876,1.672)	(−0.457,8.467)	(1.285,11.359)	(−4.889,7.634)	(−1.837,0.578)		(−127,405.400,127,810.900)
Teacher fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	986	799	799	970	910	220	959	768
R²	0.242	0.321	0.534	0.449	0.467	0.429		
Adjusted R²	0.140	0.207	0.455	0.374	0.390	0.372		
Log Likelihood								−76.173
Akaike Inf. Crit.								380.346

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8: Replication model results: first-generation status, Hispanic and/or Black students, and ISR

	Dependent variable:					
	Student ISR 1	Student ISR 2	Instructor ISR 2	Student ISR 1	Student ISR 2	Instructor ISR 2
	(1)	(2)	(3)	(4)	(5)	(6)
Student first gen.	0.026	0.024	−0.056*			
	(−0.027,0.078)	(−0.040,0.088)	(−0.113,0.001)			
Student Hispanic and/or Black				−0.032	0.007	−0.100***
				(−0.086,0.022)	(−0.059,0.073)	(−0.158,−0.041)
CGPA	−0.029	−0.079***	0.034	−0.033	−0.080***	0.029
	(−0.075,0.017)	(−0.135,−0.023)	(−0.016,0.084)	(−0.079,0.013)	(−0.136,−0.024)	(−0.021,0.079)
Course grade	0.014	0.163***	0.349***	0.012	0.163***	0.346***
	(−0.017,0.046)	(0.119,0.207)	(0.314,0.383)	(−0.020,0.044)	(0.119,0.207)	(0.312,0.381)
Constant	3.600***	3.001***	2.186***	3.668***	3.016***	2.265***
	(3.345,3.856)	(2.700,3.302)	(1.911,2.461)	(3.408,3.928)	(2.708,3.323)	(1.985,2.546)
Teacher fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,077	1,689	2,050	2,079	1,691	2,052
R^2	0.195	0.350	0.534	0.195	0.350	0.537
Adjusted R^2	0.146	0.302	0.506	0.147	0.302	0.508

Note: $^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

for course grade; $\beta = 0.432$, 95% CI[0.299,0.565] for final grade) than student perception ($\beta = 0.076$, 95% CI[0.023,0.129] for course grade; $\beta = 0.144$, 95% CI[0.017,0.271] for final grade).

Model 5 indicates that ISR perception is not significantly related to persistence.

Table 9: Replication model results: Similarity, ISR, and student outcomes

	Dependent variable:				
	Student ISR 2	Instructor ISR 2	Course grade	Final grade	Persistence
	OLS	*OLS*	*OLS*	*OLS*	*logistic*
	(1)	(2)	(3)	(4)	(5)
Treatment	−0.076***	−0.038	0.035	−0.036	0.306
	(-0.114,-0.037)	(-0.085,0.009)	(-0.028,0.098)	(-0.203,0.131)	(-0.298,0.910)
Student sim. 2	0.660***	0.119***			
	(0.631,0.688)	(0.085,0.154)			
Instructor sim. 2	0.034***	0.502***			
	(0.009,0.059)	(0.472,0.533)			
Course size	−0.102***	−0.052			
	(-0.178,-0.026)	(-0.145,0.041)			
Student ISR 2			0.076***	0.144**	−0.018
			(0.023,0.129)	(0.017,0.271)	(-0.509,0.473)
Instructor ISR 2			0.395***	0.432***	0.406
			(0.343,0.447)	(0.299,0.565)	(-0.096,0.907)
Student female			0.018	−0.098	0.242
			(-0.055,0.091)	(-0.284,0.088)	(-0.473,0.956)
CGPA			0.474***	0.407***	0.840***
			(0.420,0.528)	(0.283,0.531)	(0.413,1.268)
Constant	4.259***	2.941**	0.117	−1.366***	16.702
	(2.087,6.431)	(0.278,5.604)	(-0.238,0.473)	(-2.184,-0.549)	(-6,961.392,6,994.796)
Teacher fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	1,809	1,809	1,665	394	1,343
R^2	0.713	0.653	0.491	0.486	
Adjusted R^2	0.693	0.629	0.453	0.456	
Log Likelihood					-159.172
Akaike Inf. Crit.					558.344

Note: *p<0.1; **p<0.05; ***p<0.01

TODO: clustered residuals (low priority)

5.2 Additional results

Table 10 shows the results of models that consider matching student-instructor traits. As with the replication results, there is a statistically significant relationship between treatment and initial student similarity perception. However, the expected increase is only 0.107 on a scale of 1 to 5, which is even lower than in the replication models. There is still no significant relationship between treatment and student end-of-term ISR perception. Additionally, there is no significant relationship between treatment and standardized course grade.

TODO: Shiny.

Table 10: Additional model results

	Student sim. 2	Student ISR 2	Std. course grade
	Dependent variable:		
	(1)	(2)	(3)
Treatment	0.107***	−0.005	0.032
	(0.035,0.179)	(-0.072,0.063)	(-0.045,0.110)
CGPA			0.651***
			(0.591,0.711)
Course size	0.0004	−0.0001	−0.0004
	(-0.001,0.001)	(-0.001,0.001)	(-0.001,0.001)
Matching racial self-ID	−0.015	−0.099*	0.165**
	(-0.133,0.102)	(-0.210,0.011)	(0.038,0.291)
Matching gender self-ID	0.069*	0.053	0.110***
	(-0.006,0.143)	(-0.017,0.123)	(0.030,0.190)
Age difference	−0.007***	−0.006***	−0.008***
	(-0.010,-0.004)	(-0.009,-0.003)	(-0.011,-0.005)
Constant	3.586***	4.242***	1.220***
	(3.484,3.688)	(4.145,4.338)	(1.007,1.433)
Observations	1,819	1,819	2,065
R^2	0.020	0.014	0.200
Adjusted R^2	0.017	0.011	0.198

Note: *p<0.1; **p<0.05; ***p<0.01

6 Discussion

TODO: why did Robinson, Scott, and Gottfried (2019) pick their models? What do I think about the selection?

TODO: causal chain: intervention -> increased similarity perception -> improved ISR/ISR perception -> improved grades/persistence

TODO: Inefficacy of weak measures in the face of divergent student/instructor demographics and massive class sizes.

TODO: Who perceives similarity?

TODO: What does it mean for relationships and therefore academic success to be built on similarity.

6.1 Limitations

TODO: does this study have external validity?

TODO: very long surveys pose limitations on accuracy

A   Appendix A

Complete list of key measures

- Initial student survey:
    1. Student perceived similarity scale (s1_sim)
        – Overall, how similar to your instructor's values do you think your values are?
        – How similar are your goals for the course and your instructor's goals?
        – In general, how similar do you think your views about the course content and your instructor's are?
        – How much do you think you have in common with your instructor?
        – How similar do you think your personality is compared to your instructor's?
        – Overall, how similar do you think you and your instructor are?
    2. Student anticipated ISR scale (s1_tsr)
        – How much do you think you will enjoy learning from this instructor?
        – How friendly do you think this instructor will be towards you?
        – How encouraging do you think this instructor will be towards you?
        – If you came back to visit this instructor three years from now, how excited do you think they would be?
        – How motivating do you think you will find this instructor's class?
        – How caring do you think this instructor will be towards you?
        – Overall, how much do you think you will learn from this instructor?
- End of term student survey:
    3. Student perceived similarity scale (s2_sim)
    4. Student perceived ISR scale (s2_tsr)
        – How much do you enjoy learning from this professor?
        – How friendly do you think this professor is towards you?
        – If you came back to visit this professor three years from now, how excited do you think they would be?
        – How motivating do you find this professor's class?
        – How caring do you think this professor is towards you?
        – How encouraging do you think this professor is towards you?
        – Overall, how much do you think you have learned from this professor?
- End of term instructor survey:
    5. Instructor similarity perception (t2_sim1):
        – Overall, how similar do you think you and STUDENTNAME are?
    6. Instructor perceived ISR scale (t2_tsr):
        – How much did you enjoy helping STUDENTNAME learn?
        – How caring was STUDENTNAME towards you?
        – How often did you say something encouraging to STUDENTNAME?
        – How friendly was STUDENTNAME towards you?
        – If this student came back to visit you three years from now, how excited would you be?
        – How motivating did STUDENTNAME find the activities that you plan for class?
        – Overall, how much did STUDENTNAME learn from you?
    7. Final grade (t2_finalexam): Instructors were asked to report the student's grade on their final exam, paper, or project.
- University internal records:
    9. Course grade (grade): The final grade that the student received in the course.
    10. Standardized course grade (std_grade): The student's final grade, standardized against other grades in the course.
    11. Persistence (f17_enrolled): The student's status as of Fall term 2017: not enrolled or enrolled.

B Appendix B

Table 11: Teacher covariates for treatment and control groups

Group	N	Missing		Control	Treatment	Total	p
				N(%) = 1137 (50.0)	N(%) = 1136 (50.0)	N(%) = 2273	
Teacher gender	2273	0	Male	230 (20.2)	229 (20.2)	459 (20.2)	1.000
			Female	907 (79.8)	907 (79.8)	1814 (79.8)	
Teacher race	2273	0	Asian	37 (3.3)	35 (3.1)	72 (3.2)	0.986
			Black	7 (0.6)	5 (0.4)	12 (0.5)	
			Hispanic	35 (3.1)	34 (3.0)	69 (3.0)	
			Mixed race	615 (54.1)	621 (54.7)	1236 (54.4)	
			Unknown	24 (2.1)	21 (1.8)	45 (2.0)	
			White	419 (36.9)	420 (37.0)	839 (36.9)	
Teacher first-gen status	2273	0	0	891 (78.4)	890 (78.3)	1781 (78.4)	1.000
			1	246 (21.6)	246 (21.7)	492 (21.6)	
Teacher age	2263	10	Mean (SD)	43.4 (10.5)	43.4 (10.6)	43.4 (10.5)	0.958
Course size	2269	4	No	49.3 (44.3)	49.7 (44.9)	49.5 (44.6)	0.812
NA	NA	NA	Yes	NA	NA	NA	NA

C   Appendix C

Missing data matrix
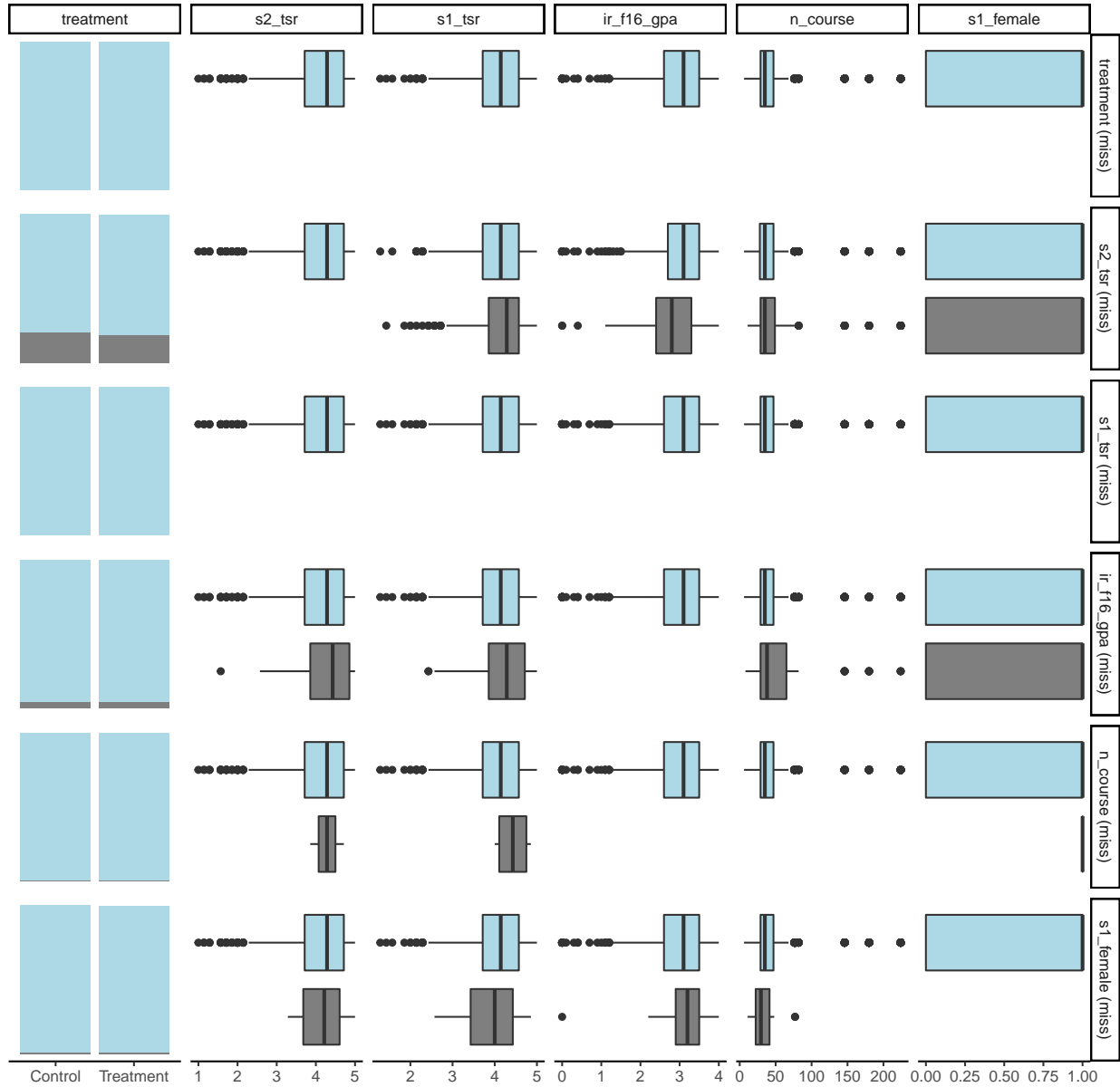
D   References

TODO: look at the references that bookdown is generating and edit bibtex accordingly.

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